What is claimed is:

[Claim 1] 1. A method of planarizing a spin-on material layer, comprising the steps of:

providing a substrate having at least an opening thereon;
forming a spin-on material layer over the substrate, wherein the spin-on material layer completely fills the opening; and
performing a plasma etching process to remove a portion of the spin-on material layer and expose the surface of the substrate, wherein the substrate is cooled throughout the plasma etching process so that an etching selectivity between the spin-on material layer on the substrate and the spin-on material layer within the opening is maintained to produce a planarized spin-on material layer.

[Claim 2] 2. The method of claim 1, wherein material constituting the spin-on material layer is selected from a group consisting of photoresist, bottom anti-reflection coating, spin-on glass and spin-on dielectric.

[Claim 3] 3. The method of claim 1, wherein the substrate is cooled down to a temperature below 50°C during the plasma etching process.

[Claim 4] 4. The method of claim 1, wherein the step of controlling the temperature of the substrate during the plasma etching process comprises passing a fluid over the back of the substrate.

[Claim 5] 5. The method of claim 4, wherein the fluid passing over the back of the substrate is a gas or a liquid.

[Claim 6] 6. The method of claim 4, wherein the fluid passing over the back of the substrate is gaseous helium or chilled water.

[Claim 7] 7. The method of claim 1, wherein the opening is selected from a group consisting of a damascene opening for forming a dual damascene structure, a trench for forming a conductive line, a via opening, a contact opening and a deep trench for forming a deep trench capacitor.

[Claim 8] 8. The method of claim 1, wherein the substrate comprises a dense opening region and a sparse opening region and the spin-on material

layer over the dense opening region has a thickness greater than the spin-on material layer over the sparse opening region.

[Claim 9] 9. The method of claim 8, wherein the plasma etching process further utilizes an etch ending signal derived from sensing the change in properties in spin-on material layer or the material on the substrate surface.

[Claim 10] 10. The method of claim 8, wherein the plasma etching process is controlled using an etch ending signal comprising a first signal and a second signal, where the first signal is produced when the spin-on material layer is removed to expose the substrate surface material in the dense opening region and the second signal is produced when the spin-on material layer is removed to expose the substrate surface material in the sparse opening region.

[Claim 11] 11. The method of claim 10, wherein the process of cooling the substrate is initiated as soon as the first signal is detected during the plasma etching process.

[Claim 12] 12. The method of claim 10, further comprising performing a etching back process to remove a portion of the spin-on material layer within the opening after detecting the second signal so that the top of the spin-on material layer is at a distance below the top of the substrate.

[Claim 13] 13. The method of claim 12, wherein the opening comprises a deep trench for forming a deep trench capacitor or a via opening for forming a dual damascene structure.

[Claim 14] 14. The method of claim 12, wherein the etching back process is carried out without cooling the substrate.

[Claim 15] 15. The method of claim 12, wherein the plasma etching process and the etching back process are performed inside the same plasma etching chamber.

[Claim 16] 16. The method of claim 10, wherein the plasma etching process further comprises:

no arrangement for cooling the substrate before detecting the first signal;
cooling the substrate after detecting the first signal but before detecting the second signal; and
stopping cooling the substrate after detecting the second signal.

[Claim 17] 17. The method of claim 10, wherein the plasma etching process further comprises:

cooling the substrate before detecting the second signal; and
stopping cooling the substrate after detecting the second signal.

[Claim 18] 18. The method of claim 1, wherein the etching selectivity between the spin-on material layer over the substrate and the spin-on material layer inside the opening is greater than 3.

[Claim 19] 19. A method of fabricating a photoresist layer, comprising the steps of:

providing a substrate having a dielectric layer thereon;
forming a plurality of openings in the dielectric layer such that the substrate is divided into two regions, wherein each of the regions has a different density of openings;
forming a spin-on material layer over the substrate, wherein the spin-on material layer completely fills the openings;
performing a plasma etching process to remove a portion of the spin-on material layer and expose the surface of the substrate, wherein the substrate is cooled during the plasma etching process so that an etching selectivity between the spin-on material layer on the substrate and the spin-on material layer inside the openings is maintained to produce a planarized spin-on material layer; and
forming a photoresist layer over the substrate.

[Claim 20] 20. The method of claim 19, wherein material constituting the spin-on material layer is selected from a group consisting of photoresist, bottom anti-reflection coating, spin-on glass and spin-on dielectric.

[Claim 21] 21. The method of claim 19, wherein the substrate is cooled down to a temperature below 50°C during the plasma etching process.

[Claim 22] 22. The method of claim 19, wherein the step of controlling the temperature of the substrate during the plasma etching process comprises passing a fluid over the back of the substrate.

[Claim 23] 23. The method of claim 22, wherein the fluid passing over the back of the substrate is a gas or a liquid.

[Claim 24] 24. The method of claim 22, wherein the fluid passing over the back of the substrate is gaseous helium or chilled water.

[Claim 25] 25. The method of claim 19, wherein the openings comprise via openings for forming dual damascene structures.

[Claim 26] 26. The method of claim 19, wherein the openings comprise trenches for forming dual damascene structures.

[Claim 27] 27. The method of claim 19, further comprising forming an anti-reflection coating over the substrate before the step of forming the photoresist layer over the substrate.

[Claim 28] 28. The method of claim 19, further comprising performing an etching back process to remove a portion of the spin-on material layer before the step of forming the photoresist layer over the substrate so that the top of the spin-on material layer is at a predetermined distance below the top of the substrate.

[Claim 29] 29. The method of claim 19, wherein the etching selectivity between the spin-on material layer on the substrate and the spin-on material layer inside the openings is greater than 3.